RESEARCH HIGHLIGHT

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West Coast Green Roof Performance at BCIT's Green Roof Research Facility

INTRODUCTION

Green or vegetated roof systems can provide environmental benefits to urban areas, including the management of stormwater run-off, reduction of air pollution and the urban heat island effect. They can also benefit building occupants by protecting the roof area from temperature extremes. Stormwater management and energy performance, in particular, are of interest in the Vancouver region.

To address a lack of West Coast climate-specific performance data and demonstrated feasibility of green roof systems, the British Columbia Institute of Technology (BCIT) constructed a dedicated field test site in 2003. The main research objective for this Green Roof Research Facility (GRRF) was to investigate the performance and practical application of extensive green roof systems. Extensive green roofs are lightweight and have shallow growing medium profiles. They are also less expensive to install and to maintain than deeper, intensive green roofs.

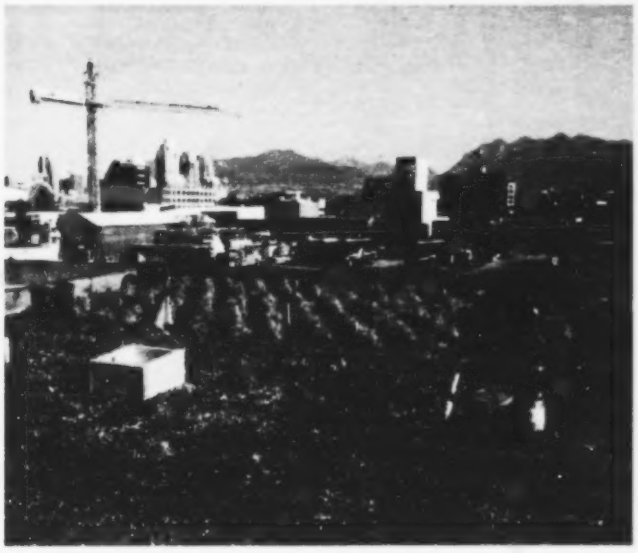

Figure 1 GRRF completion of planting 2003

The GRRF features two green roof sections separated by parapets and a non-green reference roof (REF). Both green roof systems include a root barrier, non-reservoir drainage board and independent filter cloth, and the same growing medium composition consisting of ½ white pumice, ⅛ sand and ⅜ organic compost. Green Roof 1 (GR-1) contained 75 mm of growing medium planted with sedum species while Green Roof 2 (GR-2) contained 150 mm of growing medium planted with a mix of fescues and grasses. The roof sections were fully instrumented to measure stormwater runoff characteristics and energy efficiency. The roof was monitored and performance data were collected for one full year (January 1 to December 31, 2005). The plants were fully established during this period.

In 2005, the research facility received 1,508 mm of rainfall, divided into two periods, dry and wet, based on the rainfall pattern. The dry season occurred from mid-April to the end of September, with 242 mm of rainfall.

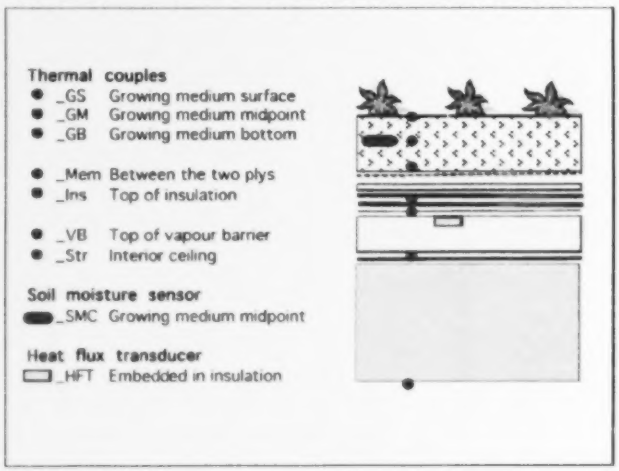

Figure 2 Cross-section of the BCIT Green Roof Research Facility's roofing system showing principal components and location of various sensors.

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STORMWATER RUN-OFF PERFORMANCE

The green roofs delayed the start of runoff and reduced the peak flow and amount of runoff. The extent of these effects varied with the particular rain event and differed for the two green roof systems. In the dry season, GR-2 retained a fraction more rainfall than GR-1, 94 per cent compared to 86 per cent. This was likely due to the higher water retention capacity of the deeper growing medium. However, the performance of the green roofs reversed in the wet season, with GR-1 providing 18 per cent retention and GR-2 providing only 13 per cent retention. It was speculated that the deeper growing medium might take longer to dry and the denser root structure of the fescues/grasses mix on GR-2 might have reduced the water holding capacity in the growing medium. The total annual rainfall retention was 29 per cent for GR-1 and 26 per cent for GR-2.

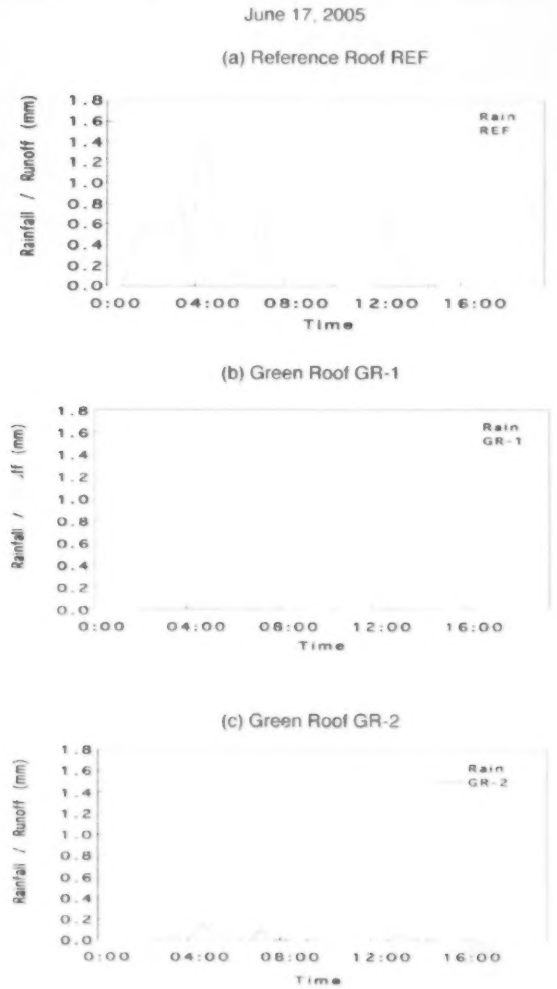

Figure 3 Reference roof and green roof runoff comparison during the June 17th rain event. 18 mm of rainfall were recorded over 12 hours and 45 minutes.

Thermal performance

The green roofs increased the thermal performance of the roofing system and consistently lowered the heat transfer between the building and its environment throughout 2005. Both green roofs were more effective in reducing heat gain than heat loss; therefore, they were more thermally effective in the summer than in the winter. The green roofs reduced the daily energy demand due to heat flow through the roof by 83-85 per cent in the spring/summer and 40-44 per cent in the fall/winter, with an overall annual reduction of 66 per cent.

Despite the difference in growth medium depth and plant species between GR-1 and GR-2, their thermal performance was very similar except during the hottest periods of July and August when GR-2 outperformed GR-1 due to the higher thermal mass of the deeper growing medium. The green roofs also lowered the maximum temperature reached by the roof membrane in the spring/summer from 50°C to less than 30°C and the median membrane temperature fluctuation from 48°C to less than 5°C. These reductions suggested that the green roofs can reduce heat aging and thermal stress on the roof membrane, thus likely increasing its service life.

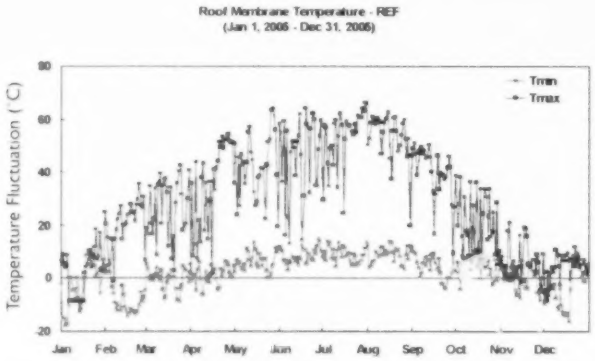

Figure 4 The daily maximum and minimum membrane temperatures measured on the Reference Roof for 2005.

Figure 5 The daily maximum and minimum membrane temperatures measured on Green Roof 1 for 2005.

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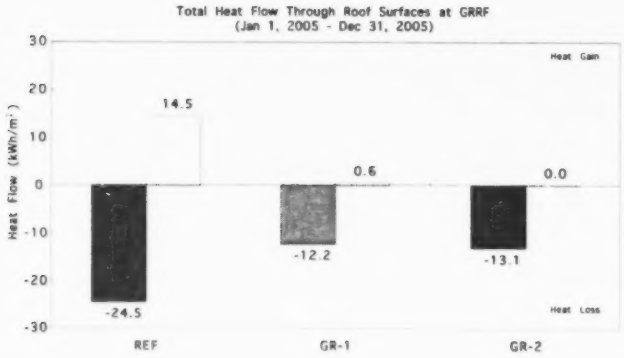

Figure 6 Annual energy demand due to heat flow through the roof for the three roof sections at the BCIT Green Roof Research Facility for 2005.

CONCLUSIONS

The first year of observation showed that, in the temperate climate of Vancouver, a green roof system with appropriate plant species in 75 mm of growing medium can provide a similar level of stormwater mitigation and thermal benefits as a green roof system with 150 mm of growing medium. The preliminary findings suggested that buildings in Vancouver could benefit from lighter weight extensive green roof systems to realize the goals of stormwater retention and reduction of thermal extremes. A second phase of study will look at stormwater.

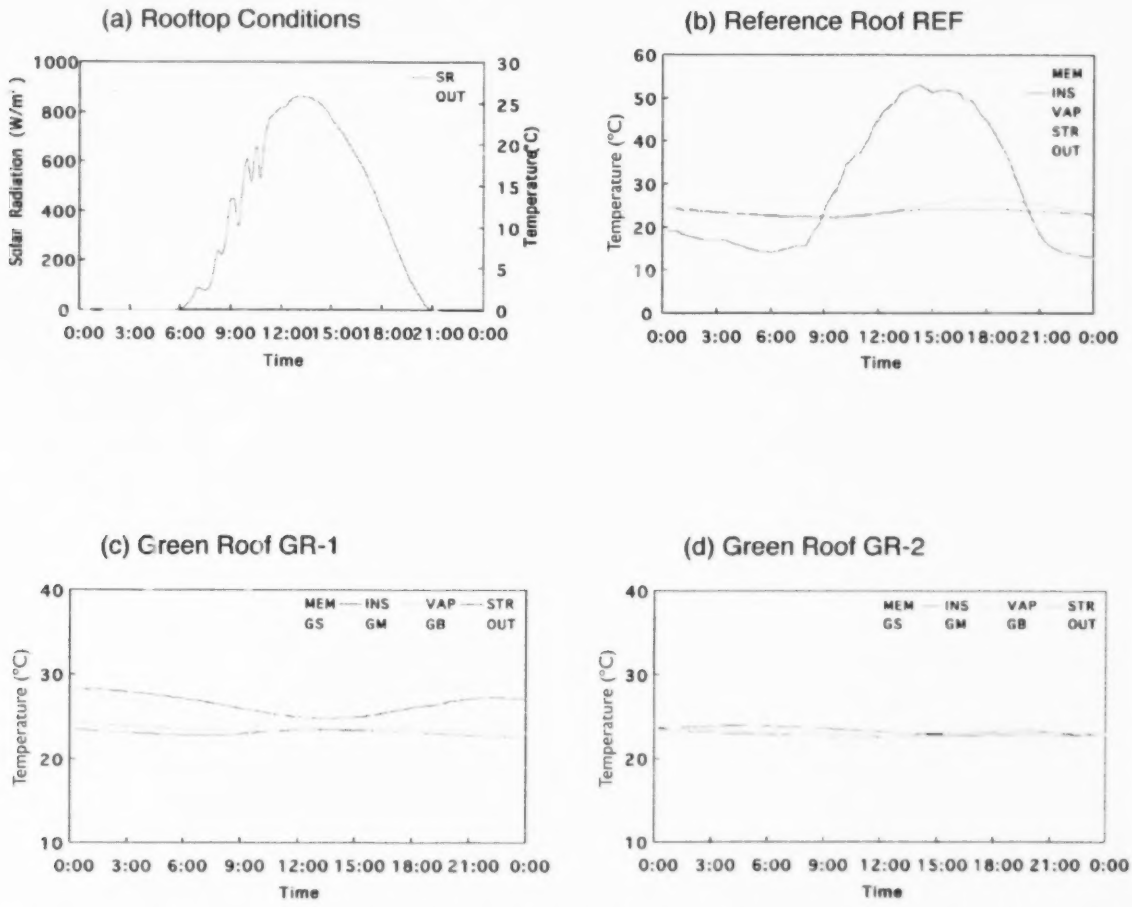

Figure 7 Weather conditions and temperature profile of the three roof sections at the BCIT Green Roof Research Facility on a typical summer day (August 1, 2005). Note that the temperature scale of the green roof plots was expanded for clarity.

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